

AMIE Overview: Study of the MJO for ASR Science

And synergy with CINDY2011/DYNAMO

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PNNL**



AMIE

ARM MJO Investigation Experiment

DYNAMO: Dynamics of the MJO

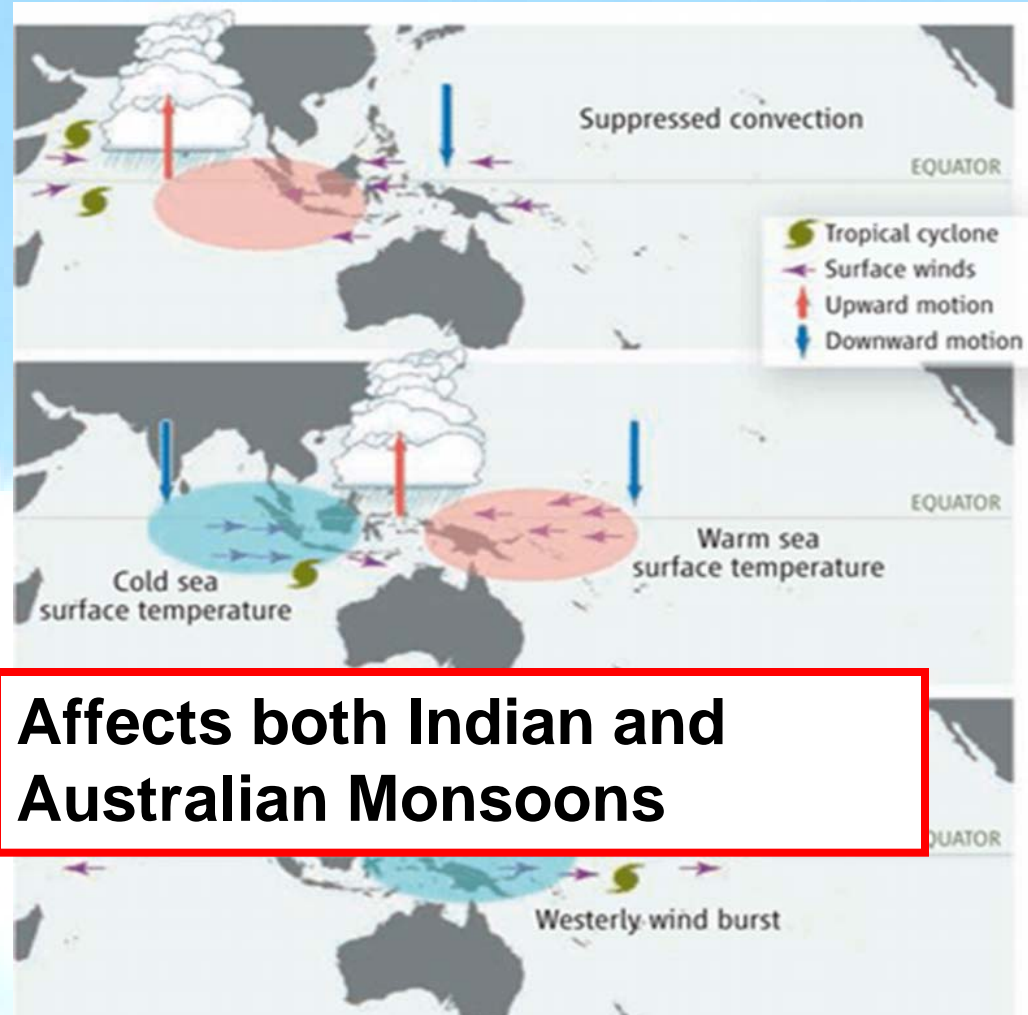
**CINDY2011: Cooperative Indian
Ocean experiment on intraseasonal
variability in the Year 2011**

AMIE Science Steering Committee

Chuck Long (PI), Tony DelGenio, Bill Gustafson, Bob Houze, Christian Jacob, Mike Jensen, Richard Johnson, Steve Klein, Ruby Leung, Xaihong Liu, Ed Luke, Peter May, Sally McFarlane, Pat Minnis, Courtney Schumacher, Andy Vogelmann, Yi Wang, Peter Webster, Xiaoqing Wu, Shaohong Xie, Chidong Zhang

MJO: A Schematic

- Occurs during boreal winter
- Area of increased convection & rainfall
- First develops in the Indian Ocean
- moves eastward at about 5 m/s
- Through maritime continent and on into TWP
- Period of ~30-60 days



Affects both Indian and Australian Monsoons

Panels separated by ~15 Days (Hartmann and Hendon, Science, 318, 1731)

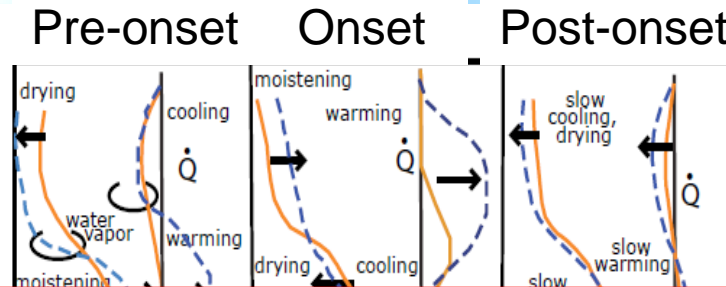
Background: Challenges presented by the MJO

- **A poster child of numerical model deficiency**
- **Inability to consistently/knowingly reproduce the MJO/TIV* by global climate models**
- **Limited intraseasonal dynamical prediction skill (< 15 days) –particularly low prediction skill during the initiation of the MJO and during the passage of the MJO convection over the Maritime Continent**
- **Limited understanding of the mechanisms for the MJO/TIV, especially their convective initiation and evolution**
- **Lack of in situ observations to test hypotheses**

*** Tropical intraseasonal variability**

Schematic conceptual model for MJO initiation at a fixed location in the Indian Ocean

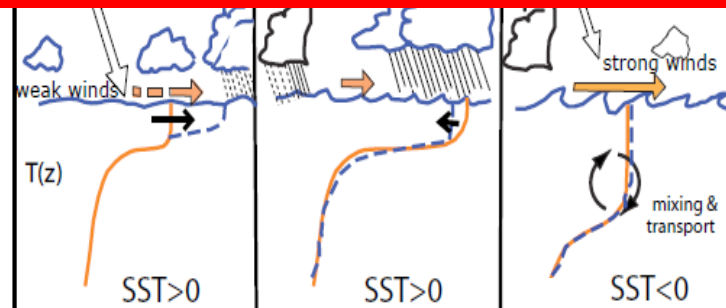
Tendency of moisture and diabatic heating



AMIE/DYNAMO

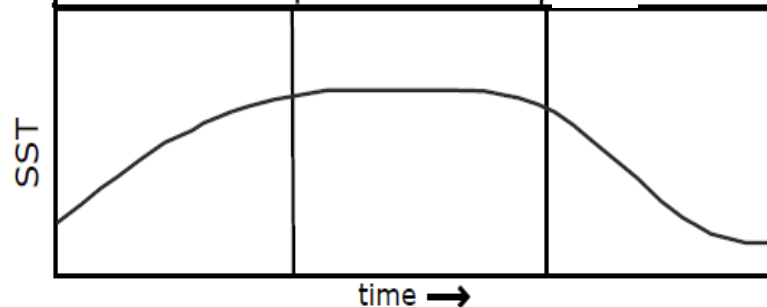
What determines the length of each stage?
What causes the transition to the next stage?

winds, and upper ocean temperature profiles

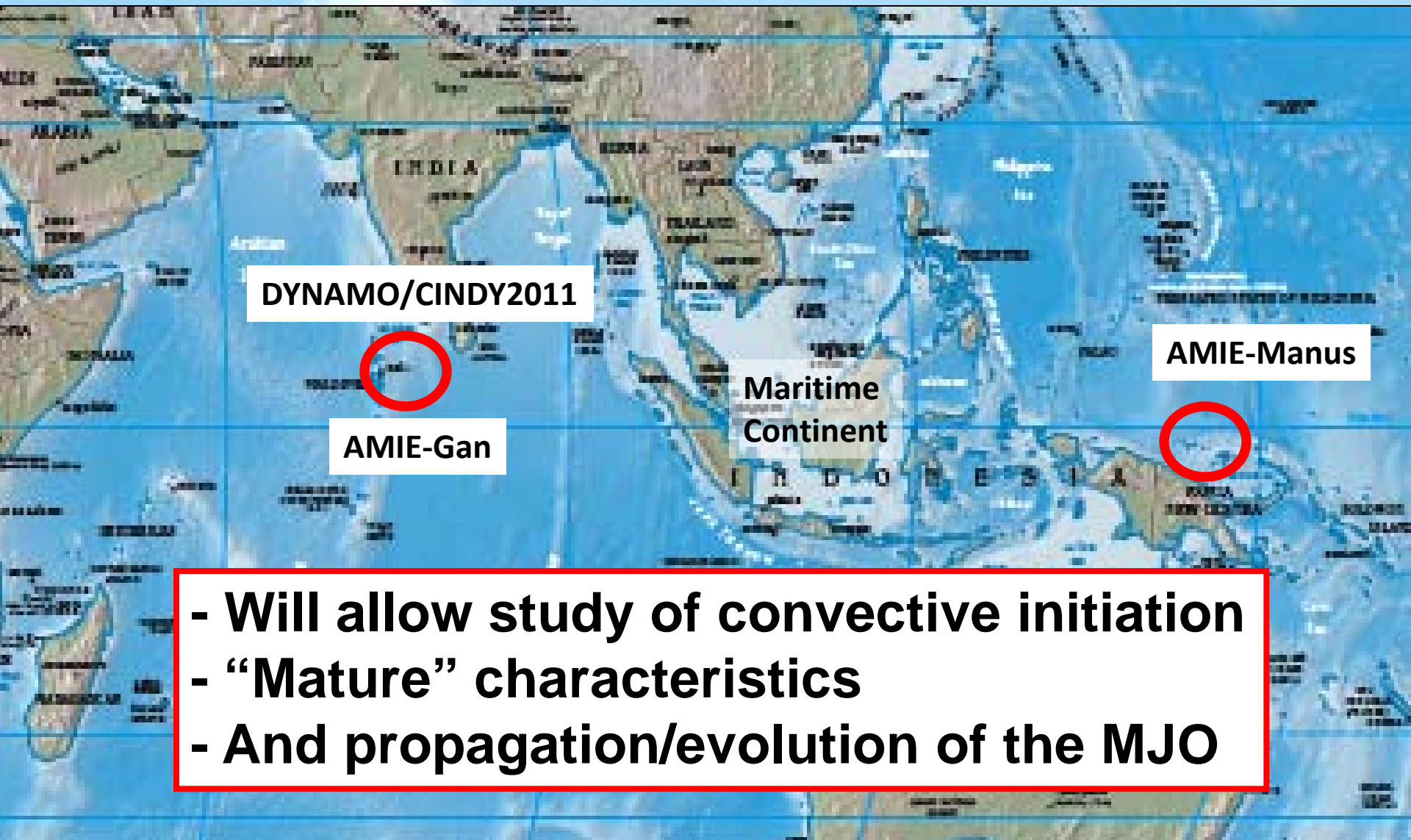


initiate, sustain, and cause the demise of each of these stages?

SST evolution



AMIE: A 2-prong Campaign



ARM/ASR Modeling Paradigm

- **Single Column and Cloud Resolving models need context**
- **ARM has developed Variational Analysis data product for this**
- **Typically required surrounding the domain with sonde launches**
- **Not practical/possible for ARM TWP equatorial sites**
- **TWP-ICE showed the powerful constraint afforded by C-POL precipitation information**

AMIE-Manus, AMIE-Gan

- **Oct. 2011 – March 2012 (coincides with CINDY2011/DYNAMO)**
- **Take advantage of scanning C, X, Ka band radars to be installed on Manus**
- **Deploy AMF2 and SMART-R on Gan Island**
 - **ARM X/Ka scanning radar, C-band SMART-R**
- **Increased sonde launches**
 - **8/day for entire period**
- **Use in conjunction with reanalysis products**
- **Produce Variational Analysis products for the entire 6-month period at each site**

Hypotheses: AMIE-Manus

Mature MJO Characterization:

- **What are the primary cloud, precipitation, and thermodynamic property differences between the active and suppressed phases of the MJO, including variations linked to interactions with the diurnal cycle, topography, and surface flux variability?**
- **Can enhanced characterization of clouds, precipitation, and thermodynamic fields during the active and suppressed phases of an MJO cycle provide new understanding and insight for improving convection and cloud parameterizations and MJO simulations in GCMs?**
- **How well do the ARM Manus site measurements capture the local scale variability and characteristics of the larger Manus area?**

DYNAMO Hypotheses emphasize three aspects highlighted in the conceptual model:

1. Deep convection can be organized into an MJO convective envelope only when the moist layer has become sufficiently deep over a region of the MJO scale
2. Specific convective population at different stages are essential to MJO initiation
3. Upper ocean processes play essential roles in MJO initiation in the Indian Ocean

**Gan
Radar
“super
site”**

Main observations/instruments of CINDY/DYNAMO/AMIE

90-120 days in the Indian Ocean (IO)

6 months at Manus and Gan (AMF2)

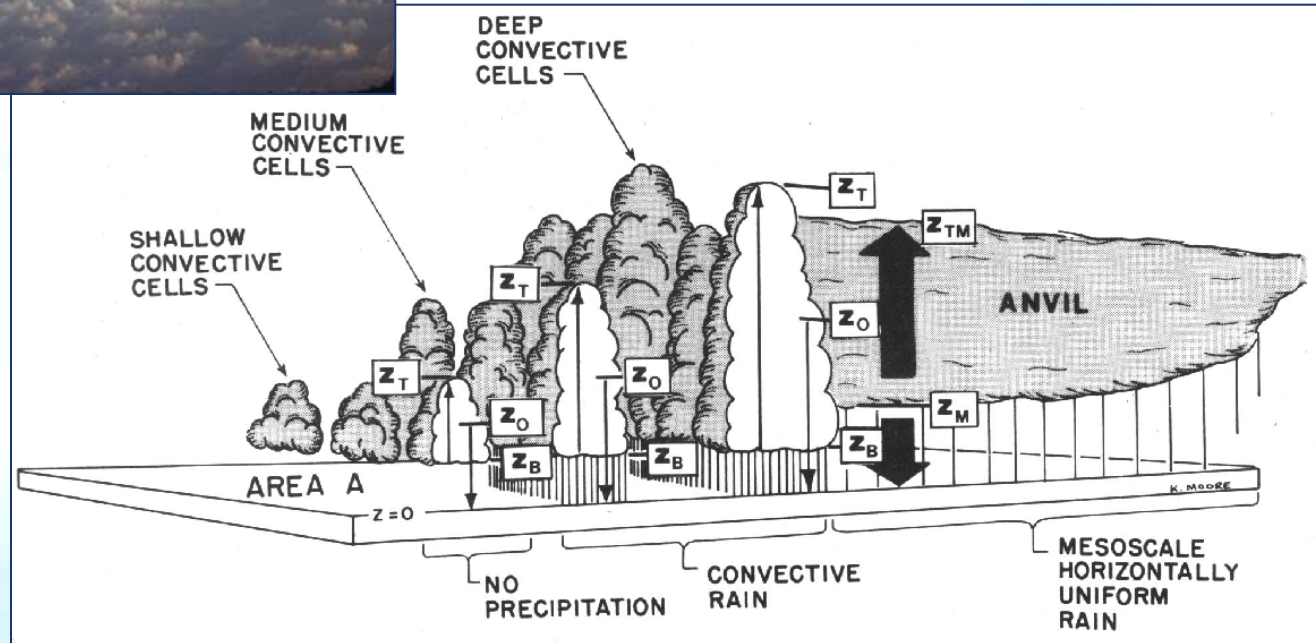
- **Atmospheric soundings (IO and Manus) and Q1/Q2 estimates (IO)**
- **Precipitation radar (IO and Manus)**
- **ARSCL (cloud radar, lidar, ceilometer) (IO - AMF2 and Manus)**
- **Surface energy fluxes (IO and Manus?)**
- **Full radiation/met package (IO - AMF2 and Manus)**
- **Aerosol (IO)**
- **Upper ocean turbulence and mixing (IO)**
- **Others**

Objective of the radar observations:



To fully characterize the ensemble of convection associated with each stage of MJO initiation, and active/suppressed mature MJO

Houze et al.
(1980)



DYNAMO Radar array

RV Revelle and RV Mirai:

- **Scanning C-band and vertically-pointing W-band radars**

Gan “Supersite”:

- **DOE AMF2 radars: Include scanning polarimetric X- and K_a -band radars and a vertically pointing K_a -band radar**
- **Texas A&M SMART-Radar: Scanning C-band**
- **NCAR S-Polka radar: Scanning, polarized, dual wavelength (K_a - and S-band)**

CINDY/DYNAMO/AMIE Synergy and Coordination

- **A rare opportunity for monitoring convective initiation and evolution of the MJO from its birth in the Indian Ocean to its middle age crisis over the Maritime Continents and propagation into the Pacific**
- **Provide observational constraints and initial conditions for model simulation/validation/development and hypothesis testing in two contrasting large-scale environments**

Project Timeline

OCT

NOV

DEC

JAN

FEB

MAR

EOP

AMIE-Gan (AMF2), SMART-R, AMIE-Manus, Darwin

IOP

End 15 Jan

**S-PolKa, RV Revelle, RV
Sagar-Kenya and RV Southern
Surveyor (plus EOP observations)**

SOP

End 9 Nov

**RV Mirai (plus IOP
and EOP
observations)**

Status

- **AMIE-Manus and AMIE-Gan funded**
 - Working on logistics and deployment issues
- **CINDY2011 (JAMSTEC & Indian Gov't) funded**
- **DYNAMO (NSF/NCAR & NOAA)**
 - “Umbrella” funding commitment
 - Individual proposal decisions in December

For consideration: An MJO Focus Group?

(Thanks, Courtney!)

Targeted science focus

Cross-disciplinary

~5-year life span

**Serve to lead development and
use of AMIE campaign data**

Thanks!